

ISSN 2320-7795  
2020 Jan. - Jun. Volume 8, Issue I



# Journal of Odontological Research

**Official Publication of  
Indira Gandhi Institute of Dental Sciences  
Nellikuzhy, Kothamangalam 686 691, Kerala, India**



**ADVANCED SCIENCE INDEX**





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# editorial

Warm Greetings from Indira Gandhi Institute of Dental Sciences...

I present before you the latest issue of Journal of Odontological Research, a periodical from this institution, published semiannually since 2013. As we all know the COVID 19 pandemic has had an impact on most academic, basic science and clinical research. All research is now redirected to COVID-19 including epidemiological studies, drug trials, vaccination trials. Most clinical trials, except those testing life-saving therapies, have been paused, and most continuing trials are now closed to new enrollment. This disruption can have a short term and long-term impact on the researchers. Let us hope that the drug and vaccination trials yield fruitful results soon, enabling us to overcome this pandemic and restore the life to normalcy at the earliest.

A scientific journal is a medium for expressing the academic standards and clinical experience of faculties of different specialties. The content of this issue appears more informative and interesting enough to enrich you with recent advances in den-



tistry. This issue includes six articles, belonging to the categories of original research, review and case reports. The original research articles- while one is clinically oriented observational study related to management of condylar fractures and the other is a survey assessing the Knowledge and attitude regarding National Oral Health Policy. The reviews are regarding current updates in luting agents, advanced diagnostic aids for oral cancer detection and melanotic lesions. This issue also includes a case report in radix entomolaris. With articles from varied topics related to oral health care, the issue will be a good read.

I take this opportunity to express my gratitude to all, who have extended their support in bringing out this issue. Wishing everyone everlasting health and happiness...

**Dr. Romel Joseph**  
Chief Editor

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## ORIGINAL RESEARCH ARTICLE

# COMPARISON OF FUNCTIONAL OUTCOME IN THE MANAGEMENT OF CONDYLAR FRACTURES- AN OBSERVATIONAL STUDY

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**ABSTRACT**

**Background:** The purpose of this study is to compare the functional outcome following surgical and nonsurgical management of mandibular condylar fractures.

**Materials and Methods:** Ten adult patients between the age group of 20 years to 50 years were included in this study. All the patients were subjected to routine blood investigation, radiographs such as OPG and Skull P.A. The study consisted of two groups of 5 patients each group. Open reduction was carried out in one group with unilateral condylar fractures and closed reduction was done in another group 5 patients with maxillo mandibular fixation and arch bars under local anaesthesia. 2mm thickness titanium plates with titanium screws 2x6mm used.

**Results:** Functional recovery after non-surgical and surgical treatment showed satisfactory results. Clicking of the temporomandibular joint on mouth opening was absent in both groups. Lateral and excursive movements were normal in both groups. No malocclusions were noticed in both groups. Pain in temporomandibular joint was noticed in 2 patients in the immediate post-operative period (40%) in the surgical group. Three patients treated by closed reduction (60%) had persistent pain in the temporomandibular joint for the first month which later got subsided gradually. Post-operative infection / wound dehiscence and unaesthetic scarring were noted in 1 patient (20%) in the surgical group at the retromandibular incision.

**Conclusion:** Based on this study there was no significant clinical difference between patients with surgically treated and those with conservatively treated unilateral condylar fractures. After both type of treatments some abnormalities remain. The radiographic examinations did show significantly better position in the surgically reduced condylar process. However satisfactory post operative function and occlusion were achieved for the surgical and non surgical groups.

**Key words:** Fracture, Temporomandibular, Reduction.



## INTRODUCTION

Mandibular fractures are third most frequent Maxillo-Facial fractures after those of nasal and zygomatic bones. Factors that influence treatment decisions include age of the patient, whether the fracture is unilateral or bilateral, presence of other mandibular fractures, the level and displacement of fracture, the presence of teeth and the degree to which occlusion is disturbed. The anatomic location and pattern of fractures are determined by mechanism of injury and direction of impact. The most common external causative factor is physical trauma, violence, industrial hazard, fall, sports and gunshot wounds. Internal causative factors include osteomyelitis, benign or malignant tumour and muscular spasm during electric shock treatment.

In the entire spectrum of Maxillo-Facial trauma no other topic has created so much of debate and controversies than that of condylar fractures regarding the treatment of fractures of condylar process over the selection of either closed or open reduction depending on displacement severity and fracture site. Many researchers recommended closed reduction with rigid or elastic maxillomandibular fixation for moderately displaced condylar fractures because of problems of surgical approach, such as difficult surgical access, salivary fistula, infection, potential damage to facial nerve and its branches and blood vessels with some approaches, difficult repositioning of the proximal fragment and possibility of post operative scar. The aim of surgical treatment of condylar fractures is to reduce to the pre-existing anatomic relationships by means of a functionally stable fixation. Open reduction should be conducted if fractured mandibular condyle is severely displaced or dislocated into the middle cranial fossa, inability to open the mouth or establish occlusion after conservative therapy, presence of intra-articular foreign body and lateral extracapsular displacement<sup>1</sup>. Closed reduction may be conducted considering various factors such as fractures without dislocation or displacement in elderly or pediatric patients, difficulty in the conduct of open reduction under systemic anesthesia, no other facial fracture and secured stability of occlusion.

The purpose of this study is to compare the functional outcome following surgical and nonsurgical management of condylar fractures of the mandible.

## MATERIALS AND METHODS

This study was undertaken on the patients who reported to Division of Oral and Maxillofacial Surgery, Rajah Muthiah Dental College and Hospital, Annamalai University, Chidambaram. Ten adult patients were included in this study belonging to age group between 20 years to 50 years. Inclusion criteria include patients who had unilateral simple, linear, non-comminuted, with or without concomitant fractures of the mandible and other associated facial bone injuries. Patients who presented with multiple comminuted, displaced or dislocated mandibular condyle fractures or high condylar fractures or below age of 20 years or severely medically compromised patient were excluded.

All the patients were subjected to routine blood investigation, radiographs such as OPG and Skull P.A. The study consisted of two groups of 5 patients each with a total number of 10 patients. All 10 patients had unilateral condylar fractures or concomitant fractures of the mandible and other associated facial bone injuries. Open reduction was carried out in one group of 5 patients with unilateral condylar fractures and closed reduction was done in another group of 5 patients with unilateral condylar fractures. Five patients underwent open reduction, under general anesthesia with retromandibular approach for the sub-condylar fractures. Fixation was carried with 2 mm 5 hole continuous titanium plate and 2x6 mm 4 titanium screws. Maxillomandibular fixation was used for a period of 2 weeks postoperatively. In closed reduction 5 patients underwent maxillomandibular fixation with arch bars under local anaesthesia. The maxillomandibular fixation was maintained for 2-4 weeks.

The radiographic investigations included Orthopantomogram (OPG) which was taken after the trauma and 3 months or more after completion of treatment. The two groups were compared for their pre-operative and post-operative mouth opening, lateral movements and occlusion with a follow up period of 3 months.



## RESULTS AND DISCUSSION

The treatment for condylar neck and subcondylar fractures remains one of the most controversial topics of mandible surgery despite the high incidence of these fractures<sup>2</sup>. The fractures of mandibular condyles are common injuries that account for 29% to 40% of fractures of the facial bones and represent 20% to 62% of all mandibular fractures<sup>3</sup>.

The most frequent cause for mandibular condyle fractures in all qualitative ranges of age are traffic accidents. The second in frequency was sports accidents in children and teenagers and casual accidents in adults. By gender the most frequent etiology was traffic accidents in both, men (62%) and women (52.6%). The second most common cause was alterations in men and casual accidents in women<sup>3</sup>.

The age of the patient, concurrent traumatic injuries, medical and dental history, current dental treatment, pathogenesis and severity of the injury, the position of the fracture and concomitant facial fractures all influence treatment of the condylar fractures<sup>4</sup>. Uwe Eckelt et al<sup>5</sup> in his study found that better functional results which were clearly in favour of open reduction and internal fixation of moderately displaced condylar fractures. In our study open reduction and internal fixation was done in moderately displaced subcondylar fractures and obtained similar functional results.

Roughly 80% mandibular condylar fractures are unilateral and 20% are bilateral, and they occur mainly between the ages of 20 and 39 years. The male: female ratio is 3:1<sup>6</sup>. In our study all patients had unilateral condylar fractures and out of ten patients only we had nine male and one female patient 9:1. Different patterns of condylar fractures were analyzed on 382 patients. A high proportion of fractures (44%) were caused by interpersonal violence, followed in incidence by falls (29%) and road traffic accidents (26%)<sup>7</sup>. In our study most common cause for condyle fracture were, road traffic accidents (40%), followed by self fall (30%) and assault (30%).

The majority of surgeons seem to favour nonsurgical treatment of condylar fractures. This preference is largely the result of 3 main factors. First, nonsurgical treatment gives satisfactory results in the majority of cases. Second, there are no large series of patients reported in the literature who

have been followed after surgical treatment because of management of condylar fractures has historically been with nonsurgical means. Third, surgery of condylar fractures is difficult because of inherent anatomical hazards (i.e., VII nerve)<sup>8</sup>. The main reason for favouring nonsurgical treatment previously were, the risk of wound infection, the close anatomic relationship of facial nerve and temporal vessels and the absence of osteosynthesis materials<sup>9</sup>.

Edward Ellis<sup>10</sup> described that bilateral fracture of condyles seem to be the one that causes most malocclusions. He treated these patients with such fractures by non-surgical means, placing arch bars and using a short course of maxillomandibular fixation followed by guiding elastics to control the occlusion and he noted patients developed anterior open bite.

Edward Ellis et al<sup>11</sup> in their study of 137 patients treated with unilateral fractures of the mandibular condylar process (neck or subcondyle) of them 77 were treated closed and 65 treated open. He found that patients with isolated condylar process fractures (no associated mandibular fractures) who were treated by closed technique had significantly more malocclusions than those treated by open reduction.

Hyde. N et al<sup>12</sup> in their study on 54 patients with condylar fractures, 33 underwent open reduction and 21 closed reduction. Mouth opening varied in both the groups. In the open reduction group the mean interincisal opening was 42mm and in the closed group it was 32mm. In our study the interincisal opening varied in both groups. In the closed group it ranged from 35 - 40mm and in the open reduction group it ranged from 36 - 46mm. The mean interincisal opening in open reduction group was 42mm and in closed group it was 38mm. The results of the clinical examination showed that there was no statistical significant difference between maximal mouth opening in both surgically and conservatively treated patients.

Severe displacement of fractured condyle can cause malocclusion, abnormal opening and impaired function. It is therefore sometimes desirable to reposition the condylar fragment, if possible. Once the condyle is displaced, however, replacement and repositioning usually cannot be achieved by nonsurgical means. The surgical treatment of condylar process fractures is to restore the preexisting anatomic relationships by means of functionally stable fixation<sup>13</sup>.

Andre H. Montazem and George Anastassov<sup>1</sup> have summarized the absolute and relative indications for open treatment of condylar fractures and absolute indications for closed treatment of condylar fractures.

**Absolute indications for open treatment of mandibular condyle fractures are:**

- (I) Dislocation of condyle into the middle cranial fossa.
- (ii) Inability to open mouth or establish occlusion after conservative treatment.
- (iii) Intra-articular foreign body.
- (iv) Lateral extracapsular displacement.
- (v) Tympanic plate injury.

**Relative indications for open treatment of mandibular condyle fractures are:**

- (I) Medical necessity (alcoholism, seizure disorder, bulimia and so forth).
- (ii) Bilateral condylar fractures in edentulous patients, when splinting is impossible because of alveolar ridge atrophy.
- (iii) Displacement of the condyle out of the fossa.
- (iv) Periodontal problem and loss of teeth

**Absolute indications for conservative therapy of mandibular condyle fractures:**

- (I) Intracapsular fractures.
- (ii) Fractures in small children.
- (iii) Fractures without dislocation..

C.A.Landes et al<sup>14</sup> listed the general justifications for open treatment, which included anatomical reduction, occlusal stability, rapid function, maintenance of vertical support, avoidance of facial asymmetry, lower postoperative incidence of temporomandibular joint disorders and no mandibulo-maxillary fixation. Arguments for closed treatment included reduced overall morbidity, acceptable occlusal results, avoidance of typical surgical complications, simpler procedure and less risk of ankylosis and avascular necrosis.

Bilateral condyle fractures are associated with symphysis fractures and unilateral fractures with opposite parasymphysis fractures. The condylar fractures result from an indirect force applied to the

mandible associated with atleast one other mandibular fracture, mostly symphyseal or parasymphyseal. This suggests that condylar fractures may be as a result of transmission of force which is not fully absorbed in the majority of cases in the area of its primary application, i.e the mental region<sup>15</sup>.

Closed reduction intermaxillary fixation is done using arch bar and wire, followed by maintaining of the fixation of the maxilla and mandible for 2-4 weeks. After achieving stable union of fractured site, a wire for intermaxillary fixation is removed. Then normal occlusion is induced after fixation using elastics and soft diet is maintained for 2 weeks<sup>16</sup>. In our study for the closed reduction group intermaxillary fixation was done using arch bar and wire for 2-4 weeks and normal occlusion was induced using elastics and maintaining soft diet.

**Advantages of closed reduction with functional therapy are:**

- (I) Relatively safe treatment.
- (ii) No injury to nerve and blood vessels occur during treatment.
- (iii) No postoperative complications such as infection or scars, and in particular fracture, loss

**Disadvantages of closed reduction:**

- (I) Injury to periodontal tissues and buccal mucosa, poor oral hygiene, pronunciation disorder, imbalanced nutrition, reduced mouth opening and respiratory disorder.
- (ii) Growth disorder and excessive growth of the injured mandible may occur due to improper reduction of bone fragments and right and left displacement of the mandibular ramus or mandibular deviation upon opening may occur after conservative treatment.
- (iii) Metastasis of the fractured bone by muscle strength, abnormal occlusion due to inappropriate fixation and inappropriate function of the temporomandibular joint due to disuse muscular atrophy caused by long term intermaxillary fixation.

**Advantages of open reduction:**

- (I) Reduction of the displaced bony fragment to the most ideal anatomical site by a direct approach.

- (ii) Prevents complications such as respiration disorder, pronunciation disorder and serve nutritional imbalance by shortening intermaxillary fixation.

#### **Disadvantages of open reduction:**

- (I) Intra operative bleeding.
- (ii) Postoperative infection.
- (iii) Facial nerve damage or paralysis.
- (iv) Functional disorder of the auriculotemporal nerve.

Many studies reported that infection occurred in 7% of patients with mandibular fracture. In addition, some studies reported preoperative infection, most of which are associated with delayed early treatment and the teeth positioned in the line of fracture<sup>17</sup>. M.F.Delvin et al<sup>18</sup>: in their study on 42 patients with fractured condyles treated by open reduction by using the submandibular approach, 19 of them were edentulous and 21 were dentate, in this one patient developed a hypertrophic scar.

In our study post operative infection, wound dehiscence and unaesthetic scarring was noted in 1 patient who was treated by open reduction and internal fixation using retromandibular approach. Patients treated by open reduction and rigid internal fixation had the advantage of more rapid return to the pre-traumatic occlusion and enhanced nutrition. On the other hand non-surgically treated patients required prolonged maxillomandibular fixation with periodic adjustments of elastics. The functional benefits for patients treated with closed reduction were as good as those treated by open reduction.

#### **CONCLUSION**

On the basis of this study we conclude there was no significant clinical difference between patients with surgically treated and those with conservatively treated unilateral condylar fractures. After both type of treatments some abnormalities remain. The radiographic examinations did show significantly better position in the surgically reduced condylar process. However satisfactory post operative function and occlusion were achieved for the surgical and non surgical groups.

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## ORIGINAL RESEARCH ARTICLE

# AWARENESS ABOUT NATIONAL ORAL HEALTH POLICY AMONG DENTAL HOUSE SURGEONS AND FACULTY

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### ABSTRACT

**Background:** The oral disease burden in India has been witnessing a paradigm shift with the changing dietary habits and lifestyles. The reported facts and figures about the various oral diseases are alarming and this reflects the state of oral health in our country. Oral diseases still remain a public health problem. National Oral Health Policy for India was drafted in 1986 and accepted by the ministry in 1995. It has not yet been implemented.

**Methodology:** The study was a cross-sectional questionnaire-based survey. A prefabricated validity tested questionnaire was devised for use. The questionnaire consisted of questions on professional data designation, grade; and 27 questions assessing the knowledge and attitude on National Oral Health Policy. Results were expressed as a number and percentage of respondents for each. Chi-square test was performed to compare the response in relation to year of study and designation.

**Results:** The final sample size was 106, which comprised of 69 (65.1%) dental house surgeons and 37 faculty (34.9%). All the respondents were aware of National Oral Health Policy. About 21.7% of the respondents knew the year in which the policy was drafted and only 11.3% (n=12) knew the year of acceptance of policy by Government of India. About 32.1% (n=34) knew that the policy was not implemented. 84% felt there were not enough opportunities for dentists in public sector. Respondents felt that Lack of awareness (71%) and affordability (50%) were the major barriers in dental health services. About 68% (n=72) opined that oral health does not receive a priority in health care delivery and policies in India. Over 92% (n=97) agreed that implementation of Oral health policy can be an effective career option for dentists in the public health sector.

**Conclusion:** This study focuses on the Knowledge and Attitude of dental faculty and house surgeons on the National Oral Health Policy for India. The study shows that although the knowledge regarding the policy was considerably low, there was a positive attitude of the respondents regarding the recommendations of the policy. The knowledge scores were significantly higher among the house surgeons compared to the faculty.

**Key words:** National Oral Health Policy, health care delivery, accessibility, affordability.

J Odontol Res 2020;8(1)11-5.



## INTRODUCTION

The oral disease burden in India has been witnessing a paradigm shift with the changing dietary habits and lifestyles. The reported facts and figures about the various oral diseases are alarming and this reflects the state of oral health in our country. Oral diseases still remains a public health problem for developed countries and a burden for developing countries like India especially among the rural population.<sup>1</sup>

India, over the years, has witnesses drastic changes in dental sector with a steady increase in dental workforce. With the opening of private dental sectors, mushrooming of dental teaching institutions and hence increasing dental graduates, it is logical to believe that oral disease burden should be reduced. On the other hand, population explosion, especially geriatric population, as well as disproportionate dental work force distribution, is being noted in India.<sup>2</sup> Probably, as a result of various economical and sociocultural reasons, it is noted that the Indian oral disorder burden has not changed over the years.<sup>3</sup>

There is a lack of a well-organized delivery system of oral health care in the public sector, especially that targets the grassroot levels of the community. India currently has enough dental workforce. One important reason for the high burden of oral diseases in the country is a lack of an oral health policy, in addition to poverty, geographic isolation and lack of perceived need for dental care, especially among masses.<sup>4</sup>

National oral health policy for India was conscripted by the Indian Dental Association (IDA) in the year 1986 and it was accepted as an integral part of National Health Policy (NHP) by the Central Council of Health and Family Welfare in one of its conferences in the year 1995.<sup>5</sup> The policy has not yet been implemented. The policy, even after 35 years of drafting, was much ahead of time. The recommendations are valid even today, that could be a possible answer to reduce the oral disease burden in India.

Hence a study was undertaken to assess the Knowledge and Attitude regarding National Oral Health Policy among Dental faculty and students in a Dental college in Kerala.

## METHODOLOGY

The study was a cross-sectional questionnaire-based survey. The target population was the clinical dental students (Third year and Final year undergraduate students), House surgeons and teaching faculty of a dental college in Kerala. A questionnaire was fabricated and was tested for content validity.

The questionnaire was divided into two parts. The first part consisted of questions on professional data designation and grade. The second part contained 24 closed ended questions assessing the knowledge and attitude regarding the National Oral Health Policy. The questionnaire consisted of 8 questions to assess knowledge and 16 questions to assess attitude.

The questionnaires were distributed by the house surgeons posted in the Department of Public Health Dentistry. The respondents filled the questionnaire on their own and were asked to return the questionnaire immediately.

Necessary ethical clearance for the study was obtained from the Institutional Ethical Committee. The respondents were briefed about the study and informed consent was obtained from all the participants prior to the administration of questionnaire. The final study sample was 183.

### Statistical analysis

All returned questionnaires were coded and analysed. Results were expressed as a number and percentage of respondents for each question and were analysed using the SPSS Version 17 software. Chi-square test was performed to compare the response in relation to year of study and designation; and the level of significance was set at  $p = 0.05$ .

## RESULTS

**Profile of the respondents:** The final sample size was 106, which comprised of 69 (65.1%) dental house surgeons and 37 faculty (34.9%). All the respondents were aware of National Oral Health Policy.

All the 106 respondents were aware of the National Oral Health Policy for India. In relation to the knowledge-based questions, about 21.7% ( $n=23$ ) of the respondents knew the year in which the policy was drafted and only 11.3% ( $n=12$ ) knew the year of



acceptance of policy by Government of India. About 32.1% (n=34) knew that the policy was not implemented. About 31.1% (n=33) knew that general dentistry services, currently is available from the community health centre level. About 39% (n=42) knew that according to the policy recommendations, general dentistry must be made available from the primary health centre level and 31% (n=33) knew that specialty dental care must be made available from Community Health Centre level. Only 7.5% (n=8) knew the recommended dentist population ratio by WHO as 1:7500. The knowledge scores were significantly higher among the house surgeons in comparison to the faculty ( $p<0.05$ )

Regarding the attitude-based questions, about 84% (n=89), felt there were no enough opportunities for dentists in public sector. Respondents felt that Lack of awareness (71%) and affordability (50%) were the major barriers in dental health services. About 68% (n=72) opined that oral health does not receive a priority in health care delivery and policies in India. Over 92% (n=97) agreed that implementation of Oral health policy can be an effective career option for dentists in the public health sector. Over 53% felt finance was the major barrier for implementation of policy in India. More than 77% (n=82) felt that implementation of the policy will not have a negative impact on private dental practice. About 90% felt that implementation of the policy will make oral care affordable. Over 98% (n=104) felt that adding oral health related chapters in school curriculum will instil a positive dental attitude among school children.

## DISCUSSION

National Oral Health Policy was drafted in the year 1984 and was accepted by the Ministry of Health and Family welfare, Government of India, in the year 1995.<sup>5</sup> Analysing the responses, all the study participants were aware of National Oral Health Policy for India. The study participants were dental house surgeons and teaching faculty members. With the topic of National Oral Health Policy being a part of dental undergraduate curriculum, in the speciality of Public Health Dentistry, the response is justifiable. As per the guidelines of the National Oral

Health Policy for India, a dental care must be made from Primary Health Centre level. About 40% of the respondents, majority of whom were house surgeons, were aware of that. It is a matter of fact that as of now, less than 20% of PHC's have a dental professional.<sup>6</sup> Only 7.5% of the respondents knew that ideal dentist population ratio, as recommended by the WHO as 1:7500.<sup>7</sup>

The analysis of results reveal that knowledge scores were poor. A comparison of knowledge scores between faculty and house surgeons revealed a higher knowledge score among interns. As stated earlier, the probable reason could be that the policy is taught in undergraduate curriculum as a part of final year topic in the speciality of Public Health Dentistry.

Literature search shows a paucity of studies conducted assessing the knowledge and attitude in relation to the National Oral Health Policy for India. The attitude scores revealed that the respondents felt that there were no opportunities for dentists in the public sector. The barriers the participants felt in utilization of dental health services included lack of awareness, followed by affordability and accessibility. An analysis of Oral Health Care system in Kerala has cited lack of knowledge as one of the threats and accessibility as one of the weaknesses.<sup>7</sup>

About 67.9% believed that oral health does not receive a priority in health care delivery and policies in India. Oral health education and indeed even emergency dentistry are low on the list of priorities when it comes to health care in developing countries, including India. This is further compounded by most countries choosing to use the little money they do have for oral health on traditional approaches of employing a very small number of fully trained dentists along with the complex equipment and expensive materials. This makes even simple treatment inaccessible to most of the population.<sup>8</sup> Limited accessibility to oral health care, poor portrayals of the severity and extent of the burden, and inertia to address-related challenges are important factors contributing to the low political priority of oral health.<sup>9,10</sup>

Vast majority of the study subjects (82%) felt that dental screening and treatment camps can effectively tackle the accessibility for the general public.

Results from the various outreach programs showed that they could assist in bridging the wide gap created between rural residents' actual dental needs and their demand for dental care.<sup>11</sup>

Almost 93% felt that implementation of the policy would be a boon to the career of dentists in public sector. As mentioned in various literature on National Oral Health Policy<sup>5,8</sup> and as per the recommendations of the policy, the implementation will truly create plenty of job opportunities in the public sector. More than 90% believed 2 months of mandatory rural posting of interns will be beneficial in providing oral health care to the community. It is an irony that while 80% of the dentists work in urban areas, around 70% of the Indian population lives in rural areas making health care a commodity that follows an inverse square law.<sup>7</sup>

As far as the budget allocation is concerned in India, the irony is that, out of the total budget, the amount that is dedicated to health expenditure is very meagre (2%), and out of this amount only a minute percentage is allocated for oral health-related activities. In fact, there is no specific separate allocation for oral health in the Indian budget.<sup>8</sup> About 86% of our respondents agreed that a separate oral health budget is necessary.

Financial consideration and lack of political priority are the major barriers in the implementation of the policy as felt by the respondents. It is true that in a country like India, our policy makers gave oral health last priority during the pilot phase of National Oral Health Care Program. They are inadequately informed about the burden of oro-dental problems and its connection with the systemic health and possibly minimal threat to the human life due to oro-dental problems makes step motherly treatment for dental public health programs.<sup>8</sup>

It is an interesting observation that majority (78%) felt that implementation of the policy will not have a negative impact on the private dental practice. This attitude highlights the positive attitude of the respondents regarding implementation of the policy. As suggested by various literature sources, implementation of such a policy will increase the accessibility and affordability to oral health care especially to the lower socio-economic strata.

Mobile dental clinics provide an innovative solution to providing dental care. They act as the first form of exposure to educate the rural people and alleviate them of their oral health care needs. Mobile Dental Unit is also a mean of comprehensive oral health care provider with oral health treatment and education being provided to the rural population at the same place.<sup>12</sup> About 85% of our respondents felt that mobile dental clinics can be beneficial in catering to the needs of the community.

It is promising to note that over 81% were willing for rural practice and as per the draft policy guidelines, if there is an incentive for rural practice, over 87% were willing for the same. This highlights that the policy, although drafted more than three decades ago, is still valid for improving the oral health care delivery as well as provide a better opportunity for the oral health care professionals.

Almost 98% of the respondents believed that adding oral health related chapters in the school curriculum will instil a positive dental attitude among the school children. Schools can provide a supportive environment for promoting oral health. Schools can also provide an important network and channel to the local community. Health promotion activities can be targeted at home and throughout the community by school personnel. This school-home-community interaction is an important aspect of a health-promoting school. An effective school oral health program is one of the most cost-effective interventions a nation can make to simultaneously improve education and oral health.<sup>8,13</sup>

Few of the recommendations of the policy<sup>14</sup> drafted more than three decades ago include appointment of a dental surgeon at the Primary Health Centre, two dental surgeons including a specialist at the Community Health Centre level, four specialist including a chief dental officer at the district level, a Director of Oral Health Services at the state level and a Additional Director General of Oral health services at the central level, with a separate budget allocation for oral health. These recommendations, in addition to the ones aimed at strengthening the public health infrastructure in relation to oral health, including the role of dental colleges, reorientation of dental practice, incentives for rural practice, inclu-

sion of chapters related to oral health in the curriculum, warning labels on chocolates, providing affordable tooth paste and oral hygiene aids, providing tax rebates on oral hygiene products etc, still hold good for improving the oral health of the community by making oral health care accessible and affordable by all. Moreover, implementation of this policy will also positively influence the career options for dentists in the public sector. Necessary amendments can be done to suit the present conditions.

## CONCLUSION

This study focuses on the Knowledge and Attitude of dental faculty and house surgeons on the National Oral Health Policy for India. The study shows that although the knowledge regarding the policy was considerably low, there was a positive attitude of the respondents regarding the recommendations of the policy. The knowledge scores were significantly higher among the house surgeons compared to the faculty.

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## RESEARCH ARTICLE

# CURRENT UPDATES ON LUTING AGENTS: A REVIEW WITH RECENT TRENDS

## ABSTRACT

The selection of an appropriate luting agent is mandatory for the long term clinical success of fixed prosthodontic restorations. Not all luting agents can meet all the stringent requirements, that is why there is such a wide choice of luting agents currently available from conventional water-based to contemporary adhesive resin cements. Introduction of adhesive resin systems has completely changed the face of fixed prosthodontic practice leading to an increased use of bonded all-ceramic crowns and resin-retained fixed partial dentures. This article tries to review recent updates and advancements on luting cements

**Key words:** Dental luting cements, Glass Ionomer Cement, luting cements, provisional and definitive luting cements, resin cements, resin modified luting cements, nanotechnology, adhesive dentistry, restorative dentistry, advantages and disadvantages, ideal requirements, recent advances.

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## INTRODUCTION

Dental cements are used as luting agents and restorative materials in the oral cavity. The most obvious use of dental cements is for permanently retaining metallic and non-metallic inlays, crowns, and bridges to tooth structure. Cements used in this manner are called Luting agents because they lute, or adhere, one surface to another. Dental cements can also be used as protecting materials after the cavity preparation to protect the pulp against further trauma, like thermal and chemical insulating bases under metallic restorations and others like composites restorations and pulp-capping agent and cavity liners. Multiple factors affect the success of fixed prosthodontic restorations with preparation design, oral hygiene/microflora, mechanical forces, and restorative materials being some of them. However, key factor to success is the choice of a proper luting agent and the cementation procedure. Loss of crown retention was found to be the second leading cause of failure of crowns and fixed partial dentures<sup>1</sup> while a study listed uncemented restorations as the third leading cause of prosthetic replacement with failure occurring after only 5.8 years of service<sup>2</sup>. This article reviews numerous luting cements, their composition, chemistry, properties with their advantages and disadvantages and advancements from the literature.

## LUTING CEMENTS

Luting agents are used like glue to retain the metallic, ceramic and composite crowns, bridges inlays and onlays permanently. In dentistry, use of dental cements as a luting agent is employed for two major purposes such as to secure cast restoration in fixed prosthodontics and to retain orthodontic bands and appliances in position, and to serve as a restorative material either alone or with other materials<sup>3</sup>. Uses of luting cements for fixed prosthodontic purposes, require preparation of the tooth surface (i.e. 1.5 to 2 mm of enamel and dentin must be removed to create space in which the cement is placed). So the most important aims of the luting cements in fixed prosthodontics are to prevent the bacteria and oral

fluids from penetration into the prepared surface and insulate the thermal conduction as well as retention of the restoration by filling the gap between the tooth surface and the restoration<sup>4</sup>. While in orthodontics, the preparation of tooth surface is eliminated (no need to remove any enamel or dentin) where the cements are placed directly on the teeth. However the most important aim of luting cements is to retain the bands in position without detachment. Various luting cements used for luting of fixed restorations and orthodontic appliances as well are zinc phosphate cements, zinc polycarboxylate cements, glass ionomer cements, hybrid ionomer cements, resin modified glass ionomer cements, polyacid modified resin cements, and resin cement.

## 1. IDEAL REQUIREMENTS OF LUTING AGENTS<sup>1,2,5-10</sup>

- Should provide a durable bond between dissimilar materials.
- Should possess favourable compressive and tensile strengths.
- Should have sufficient fracture toughness to prevent dislodgement as a result of interfacial or cohesive failures.
- Should be able to wet the tooth and the restoration.
- Should exhibit adequate film thickness and viscosity to ensure complete sealing.
- Should be resistant to disintegration in the oral cavity.
- Should be tissue compatible.
- Should demonstrate adequate working and setting times.

| PROPERTIES  | IDEAL REQUIREMENTS                                                                                                                                                                                                                                                                |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Biological  | <ul style="list-style-type: none"> <li>• Non-toxic and non-irritant.</li> <li>• Non-carcinogenic.</li> <li>• Should not cause any systemic reactions.</li> <li>• Should be cariostatic thus preventing secondary caries formation.</li> </ul>                                     |
| Chemical    | <ul style="list-style-type: none"> <li>• Should be chemically inert.</li> <li>• Should bond chemically to the enamel and dentin.</li> <li>• PH should be neutral.</li> </ul>                                                                                                      |
| Rheological | <ul style="list-style-type: none"> <li>• Low film thickness to enable the easy flow of luting cement.</li> <li>• Longer mixing and working time.</li> <li>• Shorter setting time.</li> </ul>                                                                                      |
| Mechanical  | <ul style="list-style-type: none"> <li>• High compressive strength to withstand the masticatory forces.</li> <li>• High tensile strength to reduce the brittleness.</li> <li>• High modulus of elasticity.</li> <li>• Should bond chemically to the enamel and dentin.</li> </ul> |
| Aesthetic   | <ul style="list-style-type: none"> <li>• Should not alter the color of the tooth and artificial restorations/prosthesis.</li> <li>• Should have adequate radiopacity to enable detection of secondary caries.</li> </ul>                                                          |
| Thermal     | <ul style="list-style-type: none"> <li>• Good thermal insulator.</li> <li>• Coefficient of thermal expansion (COTE) should be similar to the tooth and artificial prosthesis.</li> </ul>                                                                                          |

## 2. INDICATIONS AND CONTRAINDICATIONS FOR LUTING AGENT<sup>11,12</sup>

| TYPE OF PROSTHESIS                                                     | ZINC PHOSPHATE   | ZINC POLY-CARBOXYLATE | RMGIC            | GLASS IONOMER    | RESIN CEMENT     |
|------------------------------------------------------------------------|------------------|-----------------------|------------------|------------------|------------------|
| PFM crown.                                                             | Indicated        | Indicated             | Indicated        | Indicated        | Indicated        |
| Pressed ceramic crown, ceramic inlay, ceramic veneer, resin bonded FPD | Contra-indicated | Contra-indicated      | Contra-indicated | Contra-indicated | Indicated        |
| Patient with history of post-treatment sensitivity                     |                  | Indicated             |                  |                  | Contra-indicated |
| Crown or FPD with poor retention                                       | Contra-indicated | Contra-indicated      | Contra-indicated | Contra-indicated | Indicated        |
| Cast post and core                                                     | Indicated        | Contra-indicated      | Indicated        | Indicated        | Indicated        |



### 3. PROPERTIES OF LUTING AGENTS

The selection of a luting agent for luting of various prostheses is mainly based on their properties. Most important properties of luting agents include biological, rheological, physical, and mechanical properties. Luting agent has different physical, mechanical and biological characteristics resulting from its chemical structure<sup>2-4,11-33</sup>.

| Luting agent                 | Biological<br>(Effect on<br>Pulp) | Chemical |            |                                      | Rheological  |             |            | Physical & Mechanical |             |               |
|------------------------------|-----------------------------------|----------|------------|--------------------------------------|--------------|-------------|------------|-----------------------|-------------|---------------|
|                              |                                   | pH       |            | Solubility<br>in water at<br>24 hrs. | WT<br>(min)  | ST<br>(min) | FT<br>(μm) | CS<br>(MPa)           | TS<br>(MPa) | MOE<br>(GPa)  |
|                              |                                   | 2 min    | 24<br>hrs. |                                      |              |             |            |                       |             |               |
| Zinc<br>Phopsphate           | Severe<br>Irritant                | 2.14     | 6          | 0.2%                                 | 3 – 6        | 5 - 14      | 25         | 103.4                 | 5-7         | 13            |
| Zinc<br>Polycarboxylate      | Mild effect                       | 3.42     | 7          | 0.06%                                | 2.5 –<br>3.5 | 6-9         | 25-30      | 55-90                 | 8-12        | 4-5           |
| Glass Ionomer                | Mild effect                       | 2.33     | 5.68       | 0.4-1.5%                             | 2-4          | 6-9         | 25         | 90-<br>220            | 6-7         | 8-11          |
| RMGIC                        | Mild effect                       | 3-5      |            | 0.07-0.4%                            | 2-4          | 5-6         | 25         | 85-<br>126            | 13-24       | 4 2.5-<br>7.8 |
| Methacrylte<br>resin cements | Moderate<br>effect                |          |            | 0.0-0.01%                            |              | 2-4         | < 25       | 70-<br>172            |             | 2.1-<br>3.1   |

WT = Working Time

ST = Setting Time

CS = Compressive Strength

TS = Tensile Strength

MOE = Modulus of Elasticity

#### 4. ADVANTAGES OF LUTING AGENTS<sup>1-5, 21-33</sup>

| ZINC PHOSPHATE                                                             | ZINC POLY-CARBOXYLATE                    | GLASS IONOMER                                                                                                                  | RMGIC                                                                            | RESIN CEMENT                                         |
|----------------------------------------------------------------------------|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|------------------------------------------------------|
| Reasonable working time                                                    | Favourable tensile strength              | Adequate resistance to acid dissolution                                                                                        | Improved compressive strength, diametral tensile strength, and flexural strength | Superior compressive and tensile strengths.          |
| Adequate film thickness (25 µm).                                           | Chemical bonding                         | Anticariogenic                                                                                                                 | Less sensitive to early moisture contamination and desiccation during setting    | Available in wide range of shades and translucencies |
| Can be used in regions of high masticatory stress or long span prosthesis. | Pseudoplastic                            | Ability to absorb fluoride recharge from the oral environment makes it the cement of choice in patients with high caries rate. | Adequately low film thickness.                                                   | Low solubility                                       |
| Good compressive strength                                                  | Biocompatibility with the dental pulp    | Low film thickness and maintains constant viscosity for a short time after mixing                                              | Fluoride release similar to conventional GIC.                                    |                                                      |
|                                                                            | Adequate resistance to water dissolution | Chemical bonding                                                                                                               | Minimal post-operative sensitivity                                               |                                                      |

| ZINC PHOSPHATE                    | ZINC POLY-CARBOXYLATE                                                                  | GLASS IONOMER                               | RMGIC                                                              | RESIN CEMENT                                     |
|-----------------------------------|----------------------------------------------------------------------------------------|---------------------------------------------|--------------------------------------------------------------------|--------------------------------------------------|
| Highly acidic.                    | No resistance to acid dissolution                                                      | Initial slow setting                        | Polymerization shrinkage                                           | High film thickness                              |
| Low tensile strength              | Manipulation critical                                                                  | Sensitivity to early moisture contamination | Although rare, may elicit an allergic response due to free monomer | Marginal leakage due to polymerization shrinkage |
| No chemical bonding               | Early rapid rise in film thickness that may interfere with proper seating of a casting | MOE is lower than zinc phosphate            | Cement bulk is very hard and difficult to remove                   | Lack of anticariogenic properties                |
| Solubility in oral fluids         |                                                                                        | Post ceme-ntation sensitivity               |                                                                    | No Chemical bonding                              |
| Lack of antibacterial properties. |                                                                                        |                                             |                                                                    |                                                  |

## RECENT ADVANCEMENTS IN GLASS IONOMER MATERIALS

Different advances in glass ionomer such as compomers, condensable/ self-hardening GIC, low viscosity/ flowable GIC, fiber-reinforced GIC, chlorhexidine-impregnated GIC, proline-containing GIC, nano-bioceramic-modified GIC, and calcium aluminate GIC have been introduced in dentistry.

**1. COMPOMER:** It is a combination of the word “comp” for composite and “omer” for ionomer. Though introduced as a type of GIC, it became apparent that in terms of clinical use and performance, it is best considered as a composite.

**2. CONDENSABLE/SELF-HARDENING GIC:** These are basically, purely chemically activated resin-modified glass ionomer cements (RMGICs) with no light activation at all. It is used mainly in pediatric dentistry for cementation of stainless steel crowns, space maintainers, bands, and brackets.

**3. LOW VISCOSITY/FLOWABLE GIC:** It is mainly used as lining, pit and fissure sealing, endodontic sealers, sealing of hypersensitive cervical areas, and it has increased flow.

**4. BIOACTIVE GLASS:** Developed by Hench and colleagues in 1973, this material considers the fact that on acid dissolution of glass, there is formation of a layer rich in calcium and phosphate around the glass, such a glass can form intimate bioactive bonds with bone cells and get fully integrated with the bone. It is used in retrograde filling material, for perforation repair, augmentation of alveolar ridges in edentulous ridges, implant cementation, and infra-bony pocket correction.

**5. FIBER-REINFORCED GIC:** To improve the depth of cure, reduced polymerization shrinkage, improved wear resistance, and increase in flexural strength of GIC, alumina fibers are mixed with glass powder. This technology is called the polymeric rigid inorganic matrix material, which involves

incorporation of a continuous network/scaffold of alumina and silicon di oxide ceramic fibers.

**6. CALCIUM ALUMINATE GIC:** A hybrid product with a composition between that of calcium aluminate and GIC, it is designed for luting fixed prosthesis. The calcium aluminate contributes to a basic pH during curing, reduction in microleakage, excellent biocompatibility, and long-term stability and strength.

## INTRODUCTION OF NANOTECHNOLOGY IN GICS

Nanotechnology is introduced in conventional GIC and resin-modified GIC to improve the mechanical properties of GIC. It has been concluded that large number of modifications were carried out with GIC, and the introduction of nanotechnology had improved the general properties of GIC. Nano-resin-modified GICs (nano-RMGICs) do not possess any substantial advantage or disadvantage, in terms of surface mechanical properties, compared to conventional restorative materials.

Nanotechnology involves the use of systems, modifications, or materials that have the size in the range of 1-100nm<sup>34-35</sup>. In dentistry, uses of nano technology include implant surface modifications, production of reinforced polymeric composites by incorporation of nano-sized particles, and caries prevention.<sup>36</sup>

Recent studies have suggested that incorporation of nano-sized particles or “nanoclusters” can improve the mechanical properties of dental restorative materials such as resin composites<sup>37,38</sup>. Following are the nanotechnology-improved GICs<sup>39</sup>.

**1. POWDER-MODIFIED NANO GLASS IONOMERS:** Described for the first time by De Caluwé et al.,<sup>40</sup> it involves doping conventional GICs with nano-sized glass particles, which can decrease the setting time and enhance the compression strength and elastic modulus. The main advantages of decreasing setting times of direct restorative materials are enhanced ease of handling and manipulation.

### a. MODIFICATION USING NANO-APATITE:

Addition of nano-apatite or nano-fluoroapatite to the powder component of conventional GIC has a positive impact on the compressive, tensile, and flexural strengths of the set cement after being stored in distilled water for 7 days.<sup>39</sup>

**b. MODIFICATION WITH NANO-SIZED HYDROXYAPATITE, CALCIUM FLUORIDE, AND TITANIUM DIOXIDE PARTICLES:** It has been recently reported by Gu et al.<sup>41</sup> that the combined incorporation of HAp and zirconia (HAp/ZrO<sub>2</sub>) at concentrations of 4% volume to the GIC powder can improve the mechanical properties of the set GIC.<sup>39</sup>

### 2. NANO-FILLED RESIN-MODIFIED GICS:

Resin-modified GICs also have a polymer resin component, which usually sets by a self-activated (chemically cured) or light-activated polymerization reaction.

To develop the mechanical properties of a resin composite with the anticaries potential of GICs, these were developed. However, compared to composites, resin-modified GICs have reduced mechanical properties, including brittleness and inferior strength along with aesthetics.<sup>39</sup> To overcome these drawbacks, there have been attempts to incorporate nano-sized fillers and bioceramic particles to RMGICs.<sup>42,43</sup>

**Properties of nano-RMGICs are as follows:**

**A. BONDING OF NANO-RMGIC WITH TOOTH STRUCTURE:** More ionic bonding with tooth rather than micromechanical retention, much akin to conventional GICs.<sup>39</sup>

**B. MECHANICAL AND PHYSICAL PROPERTIES OF NANO-RMGICS:** Poor flexural strength and fatigue limit in commercially available nano-RMGICs.<sup>39</sup> Perform the worst when mechanically tested on acid challenge.<sup>39</sup> Acidic environment may jeopardize the long-term survival rate of nano-RMGICs.

**C. SURFACE MECHANICAL PROPERTIES OF RMGICS:** The aesthetic properties of dental resin composite materials have been radically

improved.<sup>39</sup>

**D. FLUORIDE RELEASE FROM NANO-IONOMERS:** Slightly increased fluoride release from nano-RMGICs at a pH of 4.<sup>39</sup>

## CONCLUSION

Dental luting agents seal the interface between the restoration and the prepared tooth. This article tries to provide an insight into the various luting agents available for the clinician from the traditional water-based cements to the newer adhesive resins. Each luting agent has different physical, mechanical and biological characteristics resulting from its chemical structure. The pros and cons of the various luting cements have been discussed, and it can be safely concluded that no one material is perfect. With the plethora of newer luting agents flooding the markets, the practitioner must have sufficient knowledge to help choose the material for each clinical situation.

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## REVIEW ARTICLE

# ADJUVANT DIAGNOSTIC AIDS FOR ORAL CANCER DETECTION: A REVIEW

### ABSTRACT

Oral cancer is considered to be a globally growing oral disease. Early diagnosis of oral cancer helps in improving cancer outcome by providing care at the earliest possible stage. Screening is a tool that is used to detect a disease in people without any signs or symptoms or examination of a group of asymptomatic individuals to detect those with higher probability of developing these conditions. Simple visual examination is being carried out as part of screening, but it is limited to subjective interpretation. As a result of this, various adjunctive methods have been suggested to enhance our ability to detect malignancy as well as areas of dysplasia which are not seen by naked eye. This paper highlights various methods of screening and assesses their value in identifying various premalignant and malignant diseases.

**Keywords:** Oral cancer, diagnosis, screening, dysplasia.

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## INTRODUCTION

Early diagnosis of oral cancer is one of the most efficient method to reduce the high mortality of such conditions. This can even lower the morbidity of these disease and its treatment, which is commonly associated with moderate or severe loss of function, asymmetry and low quality of life<sup>1</sup>. Therefore detecting these conditions at an early stage helps raising awareness among general public as well as improves access to oral health services.

Oral cancer or oral malignancy is always preceded by a precancerous lesion in oral mucosa. As reported by American Dental Association, identifying initial white or red patches within oral mucosa and removing them out is one of the most effective method to reduce its incidence and mortality. The various modalities of oral cancer detection are listed below.

### Various modalities:

#### 1. Visual examination:

A Conventional Oral Examination, using normal (incandescent) light, has long been the standard method for oral cancer screening. Conventional visual cancer screenings for some anatomic loca-

tions can be highly successful and includes assessment of high risk sites. A number of publications have suggested that Conventional Oral Examination may have limited value as a method for detecting pre-cancerous or early cancerous lesions<sup>2</sup>. Precancers and early stage cancers cannot be adequately identified by visual inspection alone and may be easily overlooked and neglected.

#### 2. Vital Tissue Staining:

##### A. Toluidine blue staining:

Toluidine blue as a vital tissue stain to aid in the early detection of the oral premalignant and malignant lesions. Tolonium chloride, (chemical name) more commonly referred to as TB, has been used for more than 40 years to aid in detection of mucosal abnormalities of the cervix and the oral cavity<sup>3</sup>. Toluidine blue is a metachromatic vital dye that may bind preferentially to tissues undergoing rapid cell division (such as inflammatory, regenerative and neoplastic tissue), to sites of DNA change associated with potentially malignant disorders or both. The binding results in the staining of abnormal tissue in contrast to adjacent normal mucosa.

### Diagnostic Aids for Oral Cancer Detection

| TEST                | PROCEDURE                                                                           |
|---------------------|-------------------------------------------------------------------------------------|
| Screening           | Visual/Oral Examination                                                             |
| Vital Staining      | Toluidine Blue Staining<br>Lugol's Iodine staining                                  |
| Biopsy              | Brush Biopsy<br>Scalpel Biopsy                                                      |
| Light based systems | Vizilite (Chemiluminescence)<br>VELscope (Autofluorescence)<br>Optical Spectroscopy |
| Experimental        | DNA Image Cytometry<br>Saliva Testing<br>Lab-on-a-chip                              |
| Imaging Modality    | Optical Coherence Tomography                                                        |

Screening procedure for detection of oral cancer using 1% toloum chloride mouth rinse. Stains were prepared according to the recommendation by Mashberg.

**Preparation** - A 100 ml of toloum chloride was freshly prepared each time by mixing 1 g toloum chloride with 10 ml acetic acid, 4.19 ml absolute alcohol and 86 ml of distilled water while a 100 ml of 1% acetic acid rinse was prepared by diluting 1 ml of glacial acetic acid with 99 ml distilled water<sup>4,5</sup>.

#### **Procedure<sup>6</sup>**

1. Oral examination and annotation of location, size, clinical characteristics, and photographing of the lesion.
2. Cleaning of the lesion with a cotton tip soaked in 10% H<sub>2</sub>O<sub>2</sub> (Cleaning of lesion with water jet).
3. Cleaning of lesion with 1% acetic acid (dehydrates the mucosa by dissolving the
4. glycoprotein and for the elimination of saliva, food, or tissue remains).
5. Cleaning of lesion with water jet.
6. Application of 1% aqueous solution of toluidine blue with cotton tip for 30 seconds
7. Cleaning of lesion with water jet.
8. Application of 1% acetic acid with cotton tip for 30 seconds (for elimination of excess of stain).

#### **B. Lugol's Iodine staining:**

Lugol's iodine consists of iodine, potassium iodide and distilled water. In contrast to Toluidine blue, Lugol's iodine is retained in normal squamous epithelial cells, but not in dysplastic or malignant epithelial cells of the cervix. Lugol's iodine solution produces a brown black stain by reaction of the iodine with glycogen. Normal mucosa contains higher amount of glycogen than abnormal mucosa and produces a brown-black stain. Glycogen content is inversely related to keratinisation. In the oral mucosa, the glycogen content varies with the keratinisation of the area of the mucosa.

Lugol's iodine when used with toluidine blue helped in delineating the inflammatory lesions and was the mean source in determining clinically the degrees of differentiation of malignant lesions as the poorly dif-

ferentiated malignant lesions without glycogen content failed to show Lugol's iodine retention<sup>7</sup>.

### **3. Oral Brush Biopsy:**

Oral cells can be obtained by different physical systems of scraping the surface of the mucosa, by rinsing the oral cavity or even by taking a sample of saliva from the patients. Brush cytology (brush biopsy; Oral CDx) is an alternative to conventional exfoliative cytology for investigating persistent oral epithelial lesions not considered suspicious for carcinoma<sup>8</sup>.

OralCDx kits consisted of

1. An oral brush biopsy instrument.
2. A precoded glass slide and matching test requisition form.
3. An alcohol/polyethylene glycol fixative pouch and a preaddressed container in which to submit the contents.

#### **Applications of Brush biopsy:**

- Detection of innocuous appearing but persisting mucosal lesions.
- Alternate for assessing lesions in patients who refuse scalpel biopsy.
- In combination with vital staining, may be useful for sampling multiple areas of patients previously treated patients with dysplasia or with Oral squamous cell carcinoma<sup>9</sup>.
- Oral candidiasis, epithelial infections due to Ebsteinbarr virus and herpes virus.

### **4. Vizilite:**

Based on the principle of 'Chemiluminescence', that is, emission of light from a chemical reaction. Chemiluminescent reactions emit light of varying degrees of intensity and lifetime, with colours that span the visible spectrum<sup>10</sup>.

#### **Vizilite kit:**

- The Vizilite kit consisted of a Vizilite 1% acetic acid solution, Toluidine Blue(TB) sticks and capsule, retractor and user instructions.
- The contents of the Vizilite1 1% acetic acid solution are purified water, acetic acid, sodium benzo-

ate, raspberry flavour, and base of propylene glycol and alcohol.

- A 100 ml of tolonium chloride was freshly prepared each time by mixing 1 g tolonium chloride with 10 ml acetic acid, 4.19 ml absolute alcohol and 86 ml of distilled water while a 100 ml of 1% acetic acid rinse was prepared by diluting 1 ml of glacial acetic acid with 99 ml distilled water.

Screening procedure for detection of oral cancer and PMD using Vizilite<sup>11</sup>.

- Conventional examination of the oral cavity using dental chair light.
- Record location, size, morphology and surface characteristics of lesion(s).
- Photograph the lesion(s).
- Rinse mouth with 30 ml of 1% acetic acid and expectorate after 1 min.
- Activate Vizilite capsule and place it in the Vizilite retractor.
- Dim surgery lights and examine the oral cavity.
- Record and photograph any findings.
- Rinse mouth with water and expectorate after 20 s.

The acetic acid wash helps to remove surface debris and reportedly cause epithelial cells to dehydrate slightly increasing the relative prominence of their nuclei. Under blue white illumination, normal epithelium appears bluish in color, whereas abnormal epithelium appears distinctly white or acetowhite. The TB is used as a marking dye to help highlight lesions identified with the light source.

## 5. Optical Spectroscopy

Optical spectroscopy allows non-invasive physical and chemical characterization of biological tissues. The structural and chemical composition of cells and tissues strongly influences their optical features, and therefore alterations in the optical characteristics may indicate the presence of diseased tissue. Optical spectroscopy may provide possibilities in the early detection of cancerous tissues in humans<sup>12</sup>.

## 6. Autofluorescence:

It is the fluorescence of tissues to which no chemical

substances have been applied: it is the natural fluorescence of the tissue itself ('auto'). Fluorescence in general is the process by which excitation with light evokes the emission of light of a different (lower) wave length. When cells interact with light they become excited and re-emit light of varying colours (fluorescence) and this can be detected by sensitive spectrometers. All tissues fluoresce due to the presence of fluorescent chromophores (fluorophores) within them<sup>13</sup>.

VELscope is an equipment designed to work under the principle of Fluorescence. It uses a specific wavelength of blue light, transmitted through a halide lamp, to excite tissue from the epithelial surface, down through the basement membrane, stopping at the stroma. The lighted tissue, in turn, emanates a green fluorescence (sometimes referred to as autofluorescence). The emitted fluorescence is not visible to the naked eye, but the VELscope hand piece filters out the blue light, so that only the green fluorescence remains. Differences in the degree of green reveal possible abnormalities. Healthy tissue appears pale, lime green, while abnormal tissue appears dark green to dark rust.

The proposed mechanism of tissue fluorescence is that mucosal tissues have a reflective and absorptive pattern based on naturally occurring fluorophores in the tissue. Tissue fluorescence in the oral cavity is variable and is affected by structural changes, metabolic activity, the presence of haemoglobin in the tissue, vessel dilatation and, possibly, inflammation. This variability has not been defined. Exposure to blue light spectra (400-460 nanometres) may maximize a differential profile in areas undergoing neoplastic change in which a loss of fluorescence visualization is reported<sup>13</sup>.

VELscope is a portable unit that can be placed on a counter top or mobile cart to be transported to different operatories in an office or clinic. To prevent cross-contamination, VELscope comes with inexpensive disposable caps and sheaths that protect the patient, practitioner, and unit. A disposable retractor helps access to the oral cavity, and includes markings for measurement of the lesion. The FDA approved VELscope in 2006 as an adjunct to a conventional, incandescently lighted oral exam to aid detection of tissue abnormalities, such as cancer or

OPLs, not necessarily visible without additional technology. VELscope has also been approved for use by surgeons to help identify diseased margins of clinically visible lesions<sup>14</sup>.

### 7. DNA Image Cytometry:

It determines the malignant potential of cells by measuring the ploidy status. Alterations in cellular DNA content is identified by means of computer assisted analysis. If genomic instability is appreciated, it marks a slight contribution towards cancer development and abnormal DNA content may distinguish the dysplastic lesions that can result in cancer<sup>15</sup>.

### 8. Saliva Testing:

It is a non invasive technique that is alternative to serum testing. Saliva is often used as a diagnostic tool, as it is easy to collect and this testing may be an effective modality of cancer diagnosis as well as determining prognosis and monitoring post therapy status. Many reports mentioned that saliva may provide a cost effective practical approach for screening majority of people. This test may be used to detect specific salivary macromolecules, enzymes, cytokines, growth factors, MMP's, mRNA and DNA transcripts<sup>16-18</sup>.

### 9. Lab-on -a Chip:

It is a microfluidics technology, which is the adaptation, miniaturization, integration and automation of analytical laboratory procedures into a single device or chip<sup>19</sup>. This chip uses a membrane associated cell proteins that are expressed on the cell membranes of dysplastic and cancer cells in order to detect cells with dysplastic features.

### 10. Optical Coherence Tomography:

Optical Coherence Tomography is a kind of non imaging modality which is non invasive. It can detect areas of inflammation, dysplasia and cancer.<sup>20</sup> It mainly records subsurface reflections to build a cross-sectional architectural image of the tissue. It utilized gold nanoparticles to enhance the contrast in these images.<sup>21</sup> Studies need to be conducted to

upgrade its reliability to provide a diagnosis for cancerous lesion, still not specific.

## CONCLUSION

Oral health professionals may play a vital role in early diagnosis of oral cancer and should be considered as a priority health objective. Detection at an early stage can reduce complications related to various cancer therapies and can result in a better prognosis. Therefore, it is acknowledged that in addition to screening, there are other diagnostic adjuncts that are important in preventing oral cancer. Minor biopsy procedures can be effective for evaluating suspicious lesions that have malignant potential. Light based techniques mentioned above can be used along with oral screening as some lesions may be overlooked on conventional visual examination of the oral cavity. Early diagnosis may result in less aggressive treatment which can improve the quality of life as well as the survival rate.

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## REVIEW ARTICLE

# ORAL MELANOTIC LESIONS: A CLINICIAN'S MAZE

## ABSTRACT

The diagnosis of oral melanotic lesions within the oral cavity is often challenging. The clinical appearance of these lesions appear similar hence definitive diagnosis calls for the need of detailed histopathological evaluation. The colour, location, duration, distribution and appearance of melanotic lesions along with past medical history play an important role in arriving at an accurate diagnosis.

**Key words:** Melanin, Pigmentation, Macule.

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## INTRODUCTION

The identification of pigmented tissue within the oral cavity poses a diagnostic dilemma for the clinician.<sup>1</sup> The colour of oral mucosa varies in different physiological and pathological conditions.<sup>2</sup> The clinical presentation of mucosal pigmentation is variable and can range from focal to diffuse macule, small nodular growth to a large mass<sup>1</sup>. They may be black, gray, blue, purple or brown in color. The color of oral pigmentation may vary depending upon the quantity, depth or location of the pigment. Generally, the surface shows brown pigmentation and those located deeper are black or blue.<sup>2</sup>

Melanocytes are located in the stratum basale and produce melanin. Melanin is transferred to adjacent keratinocytes via membrane-bound organelles called melanosomes.<sup>3</sup> When skin is exposed to sunlight, melanocytes produce more pigment, causing the skin to tan. Sometimes clusters of melanocytes form non cancerous (benign) growths called moles. Moles can be either flat or raised, round or oval, and are smaller than a pencil eraser. (Generally harmless, but can become cancerous)<sup>4</sup>.

Melanin pigments can be classified into two major types eumelanin (dark brown and black) and pheomelanin (yellow, red, and light brown) based on their biosynthetic pathways.<sup>5</sup> Human melanocytes reside not only in the epidermis and in hair follicles but also in mucosa, cochlea of the ear, iris of the eye, and mesencephalon of the brain as well as other tissues.<sup>6</sup>

## WORKING CLASSIFICATION

A precise classification of these lesions will guide the clinician for better diagnosis and treatment planning.

### Based on the etiology

- a. Endogenous factors
- b. Exogenous factors

#### a. Endogenous factors

1. Physiologic pigmentation
2. Genetic disorder: Peutzjegers syndrome, McCune Albright syndrome, Von Recklinghausens disease.

3. Developmental: Nevus
4. Endocrine diseases: Addisons disease, Chloasma
5. Neoplastic: Malignant melanoma
6. HIV associated pigmentation
7. Idiopathic pigmentation
8. Post inflammatory pigmentation

#### b. Exogenous factors

1. Drug induced
2. Heavy metal exposure
3. Smokers melanosis
4. Reactive pigmentation : Post traumatic pigmentation, Oral melanotic macule, Oral melanoacanthoma.

Oral pigmentation may be exogenous or endogenous in origin. Exogenous pigmentation is mainly associated with foreign-body implantation in the oral mucosa. Endogenous pigments include melanin, haemoglobin, hemosiderin and carotene.<sup>6</sup>

## Description of lesion

### Physiologic pigmentation (Racial Pigmentation)

Physiologic pigmentation occurs as a result of increase in the production of melanin pigment by basal melanocytes. The hue of physiologic pigmentation varies from light brown to black in colour. Physiologic pigmentation can be either multifocal or diffuse in nature and is influenced by physical, mechanical and chemical stimulation. (Dummet et al)<sup>3</sup>. Ethnic pigmentation is symmetrical in distribution and rarely affects the surface topography or disturbs the normal stippling of gingiva.<sup>4</sup>

It is more evident in darker skinned individuals.<sup>3</sup> It is more common in African, Asian and Mediterranean populations.<sup>2</sup> Physiologic pigmentation occurs as a result of greater melanocyte activity rather than greater number of melanocytes. The most common location are attached gingiva, buccal mucosa, hard palate, lips and tongue.<sup>6</sup>

## GENETIC DISORDERS

### PeutzJeghers syndrome

The Peutz-Jeghers syndrome is characterised by mucocutaneous macules, intestinal hamartomatous polyposis, and increased risk of carcinomas of the gastrointestinal tract (small intestine), stomach, colon pancreas, breast, and thyroid. It has Autosomal dominant mode of inheritance with germline mutations involving the gene *STK11/LKB1*.<sup>3</sup>

Oral lesion may appear as black-to-brown spots of less than 1 mm in size and are typically localized in the lower lip and perioral area. As age progresses melanotic macules in the oral cavity may eventually fade or disappear and perioral lesions tend to persist.<sup>7</sup>

The clinicopathologic criteria by World health organisation include (Any one criteria is sufficient enough for the diagnosis of PeutzJeghers syndrome)

1. Three or more polyps, with histological features of PJS
2. A family history of PJS with any number of polyps
3. A family history of PJS with characteristic mucocutaneous pigmentation
4. Characteristic mucocutaneous pigmentation with any number of polyps.<sup>8</sup>

### Mc cune Albright syndrome

Mc cune Albright syndrome (MAS) is characterised by polyostotic fibrous dysplasia in combination with extra skeletal manifestations which include endocrinopathy and cafe au lait macules. MAS commence with the appearance of Café-au-lait spots which are apparent at or shortly after birth. These lesions are evident along the midline of the body and are characterised by irregular, jagged borders which are said to resemble the 'Coast of Maine', in contrast to the smooth-bordered 'Coast of California' macules seen in Neurofibromatosis.<sup>9</sup>

Mutation of *GNAS1* gene results in autonomous function of bone through parathyroid hormone

receptor; in skin through melanocyte-stimulating hormone receptor; in ovaries through the follicle-stimulating hormone receptor; and in the thyroid and pituitary gland through the thyroid and growth hormone receptors respectively.<sup>10</sup>

### Von Recklinghausens disease (Neurofibromatosis Type 1)

It is an autosomal dominant disorder characterized by multiple cutaneous lesions and tumors of the peripheral and central nervous system.<sup>11</sup> Patients may present with Cafe-au-lait spots which are sharply defined light brown patches, Neurofibromas, Axillary freckling, Lisch nodules and skeletal abnormalities.

### Diagnostic criteria for neurofibromatosis1 (NF1) (NIH consensus development conference 1988)

1. 6 or more café au lait macules (.0.5 cm in children or .1.5 cm in adults)
2. 2 or more cutaneous/subcutaneous neurofibromas or one plexiform neurofibroma
3. Axillary or groin freckling
4. Optic pathway glioma
5. 2 or more Lisch nodules (iris hamartomas seen on slit lamp examination)
6. Bony dysplasia (sphenoid wing dysplasia, bowing of long bone, pseudarthrosis)
7. First degree relative with NF1.<sup>12</sup>

## Developmental

### Nevi

Melanocytic nevi are benign tumors that arise as a consequence of melanocytic growth and proliferation. Skin is the most common site whereas intramucosal melanomas are more commonly seen within the oral cavity. Genetic and environmental factors play an important role in the development of melanocytic nevi. Nevus cells are distinct biologically and morphologically from the melanocytes and appear as round, ovoid or spindle-shaped.

Based on evolution nevi can be classified into

1. Junctional nevus
2. Compound nevus
3. Intradermal nevus

Oral nevi may present as a well circumscribed macule with colour ranging from brown, bluish gray to black. An early melanoma may be mistaken for melanocytic nevi making biopsy mandatory for the definitive diagnosis.<sup>3</sup>

An aid in the differential diagnosis of nevi is that they are elevated from the mucosal surface where as melanotic macules and amalgam tattoos are usually flat. Vascular lesions can be mistaken for melanocytic proliferations, the former usually blanch with compression and aspiration of the lesion can be useful in differentiating a naevus from vascular lesion.<sup>4</sup>

## Endocrine diseases

### Addisons disease

Primary adrenal insufficiency (Addison disease) occur as a result of auto immune destruction of Adrenal cortex resulting in diffuse dark pigmentation of skin and oral mucosa.<sup>13</sup> The most common intra oral sites include lips, gingival, buccal mucosa, hard palate, and tongue. Pigmented lesions often precede skin manifestations.<sup>7</sup>

### Chloasma

Chloasma (Melasma) is characterised by symmetrically distributed brown macule on face. It is more common in females and occur in association with sunlight exposure, pregnancy (mask of pregnancy), use of birth control pills. Lesions are sharply delineated and it involves malar eminences, forehead, upper lip, and mandible.<sup>14</sup>

### Neoplastic

#### Malignant melanoma

Malignant melanoma is an aggressive tumor of melanocytes, accounting for 0.5% of all oral malignancies. Etiology remains unknown and possible risk factors include tobacco use and chronic mechanical irritation resulting from ill-fitting dentures. It can arise de novo from apparently normal

mucosa and around 30% of cases are preceded by oral pigmentations for several months or even years. The colour may vary from brown, black, gray, purple, red and can even present as a depigmented lesion.<sup>7</sup>

Oral mucosal melanomas are reported in fourth to seventh decade of life, more common in males and the most common sites include palate and gingiva. Oral mucosal melanoma behaves in a more aggressive fashion than cutaneous melanoma. Treatment involves radical surgical excision with clear margins. The prognosis for oral melanoma is poorer when compared with cutaneous lesions, and the overall 5-year survival rate is 15%. The best way to improve prognosis is early diagnosis.<sup>2</sup>

### HIV associated pigmentation

HIV associated pigmentation appear as asymptomatic, single or multiple, well or ill-defined, and light to dark brown macule of varying size and shape. It can affect any part of the oral mucosa and proposed etiopathogenesis includes HIV induced cytokine dysregulation and adrenocortical dysfunction in HIV positive subjects with low CD4+T cell counts.<sup>15</sup>

### Idiopathic pigmentation

Idiopathic pigmentation includes Laugier-Hunziker pigmentation which is characterized by multi-focal pigmentation of the labial and buccal mucosa.<sup>2</sup>

### Post inflammatory pigmentation

It occurs as a result of inflammation or injury. They can be either hyper or hypo pigmentation and the most common examples are allergic reactions from insect bites or contact dermatitis, psoriasis or lichen planus etc.<sup>16</sup>

### Drug induced pigmentation

Drug induced hyperpigmentation is often idiopathic and it affects elderly individuals. Drugs like Minocycline, Levofloxacin, Rifampicin, Angiotensin II receptor antagonists, Calcium channel blockers are more commonly involved.<sup>1</sup>

### Heavy metal exposure

Heavy metals like lead, cadmium, mercury and zinc are responsible for hyperkeratosis and pigmentary changes.<sup>1</sup>

### Smokers melanosis

Smokers melanosis often affects the attached gingiva, hard palate, buccal mucosa, ventral surface of tongue and labial mucosa of tobacco smokers.<sup>17</sup> Smoker's melanosis does not require treatment, and disappearance have been reported after cessation of the smoking habit.<sup>7</sup> Smokers melanosis frequently involves anterior gingiva and most often occurs in women who smoke and take oral contraceptives.<sup>4</sup>

### Reactive pigmentation

#### Oral melanotic macule

Oral melanocytic macule may present as a solitary melanocytic lesion predominantly involving labial mucosa, lower lip, gingiva and palate and frequently involves adult female patients.<sup>7</sup>

#### Oral melanoacanthoma

Oral melanoacanthoma is a rare, benign pigmented lesion characterized by hyperplasia of spinous keratinocytes and dendritic melanocytes. It is believed to be reactive in origin and etipathogenesis remains uncertain. Any mucosal site may be involved still buccal mucosa remains as the most common site. It may present as an ill-defined, rapidly enlarging, macule commonly observed in young individuals. Since it may mimic melanoma definitive diagnosis is obtained with histopathology and biopsy procedure itself can result in spontaneous regression of lesion.<sup>1</sup>

### CONCLUSION

Many pigmented lesions can be clinically diagnosed based on age of the patient, site, size, shape, colour of the lesion, history of previous surgery, trauma followed by biopsy along with other relevant clinical information. Above information is necessary for establishment of effective clinical manoeuvres for pigmented lesions of oral mucosa as it is crucial in the exclusion of possible malignancies. Pigmented lesions comprise a large component of those lesions which has a wide spectrum of histological appearances, most can be reported as simple benign nevi.

Any pigmented or partially pigmented oral lesion

either macular or nodular should not be missed in the diagnosis. A small number will be typical malignant melanomas, although small in number are very important clinically and often results in both under & over diagnosis of melanoma. Therefore, it is important to approach all melanocytic lesions in a ritualistic & consistent manner to avoid potential serious diagnostic errors.

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## CASE REPORT

# ENDODONTIC MANAGEMENT OF RADIX ENTOMOLARIS: TWO CASE REPORTS

### ABSTRACT

A thorough knowledge of anatomy is necessary for the success of endodontic treatment. Anatomical variations should be kept in mind during endodontic treatment of maxillary molars. These teeth have highly variable root canal morphology. This case report describes the diagnosis and endodontic management of mandibular first molar with four canals.

**Key words:** Endodontic treatment, radix entomolaris.

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J Odontol Res 2020;8(1)38-42.

## INTRODUCTION

The aim of endodontic therapy is to effectively eliminate the bacteria from the root canals, which have been infected by microorganisms and to avoid recontamination of the canals, which are mainly attained by proper cleaning and shaping, followed by a three dimensional fluid-tight seal of root canals. A clinician should have a proper knowledge of the root canal anatomy and its variations such as extra roots, fins, webs, and isthmuses, which make the treatment complicated.<sup>1</sup> Lack of understanding of the root canal morphology and improper shaping and cleaning can lead to the flare-ups.<sup>2</sup>

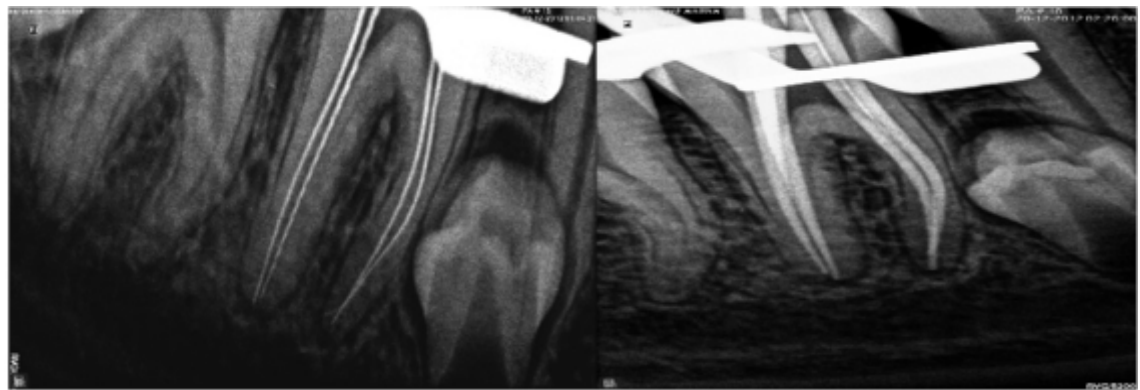
A clear understanding of the human teeth anatomy is a prerequisite to achieving proper access cavity preparation, thorough cleaning, disinfection and obturation of the pulp space. These objectives can be achieved by detecting the anatomical variations of the tooth under treatment. One of the major reasons for failure of root canal therapy is the inadequate

knowledge about the anatomy of the pulp space in the root canals. Root canals are left untreated when the dentist fails to identify them particularly in teeth that have additional root canals.<sup>3</sup>

## CASE REPORTS

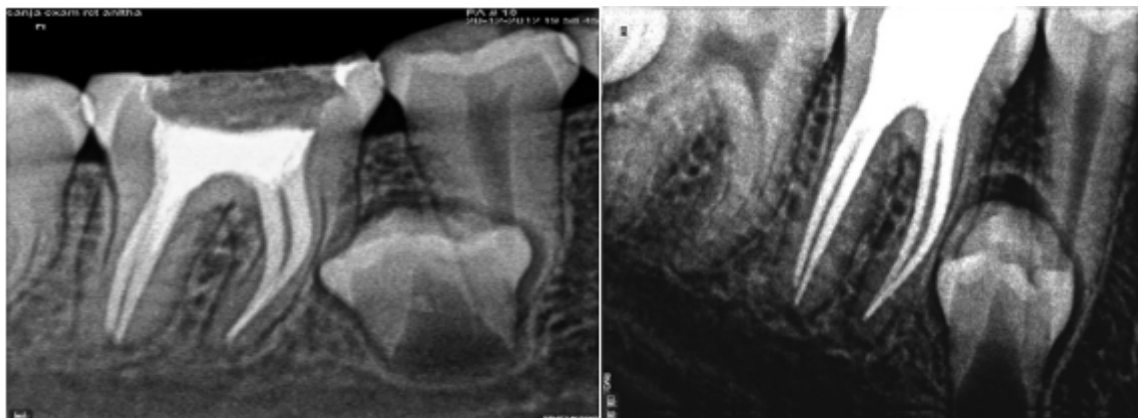
### Case 1

A 25year old female patient reported to the Department of Conservative Dentistry and Endodontics with a chief complaint of pain in lower-left back tooth region for 1 month. The patient revealed a history of mild intermittent pain for the past 2 months, which had increased in intensity during the past 2 weeks. The patient reported prolonged sensitivity to hot and cold substances. The pain was spontaneous and aggravated particularly at night. Clinical examination revealed deep occlusal carious lesions on mandibular first molar. The tooth 36 was



**Working Length**

**Mastercone**



**Obturation**

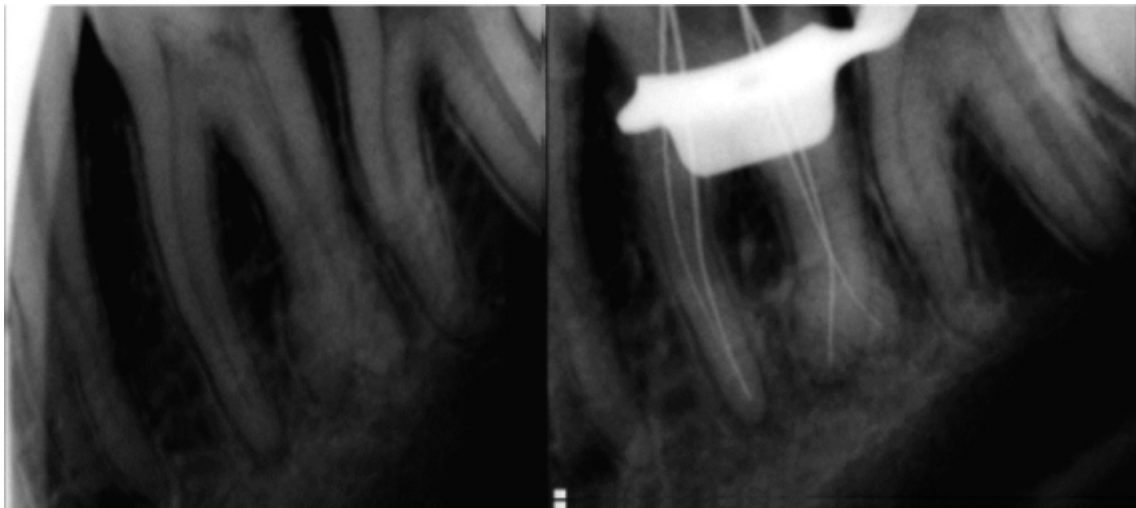
**Postoperative Radiograph**

tender to vertical percussion. Periodontal probing around the tooth showed normal alveolar bone morphology, normal sulcular depth, absence of pocket. The preoperative radiograph revealed radiolucency of carious lesion involving the pulp with respect to 36. Based on the clinical and radiographic findings, a diagnosis of symptomatic irreversible pulpitis with symptomatic apical periodontitis with respect to 36 was made and routine nonsurgical endodontic treatment was planned. Treatment plan was explained to the patient and consent obtained.

## Case 2

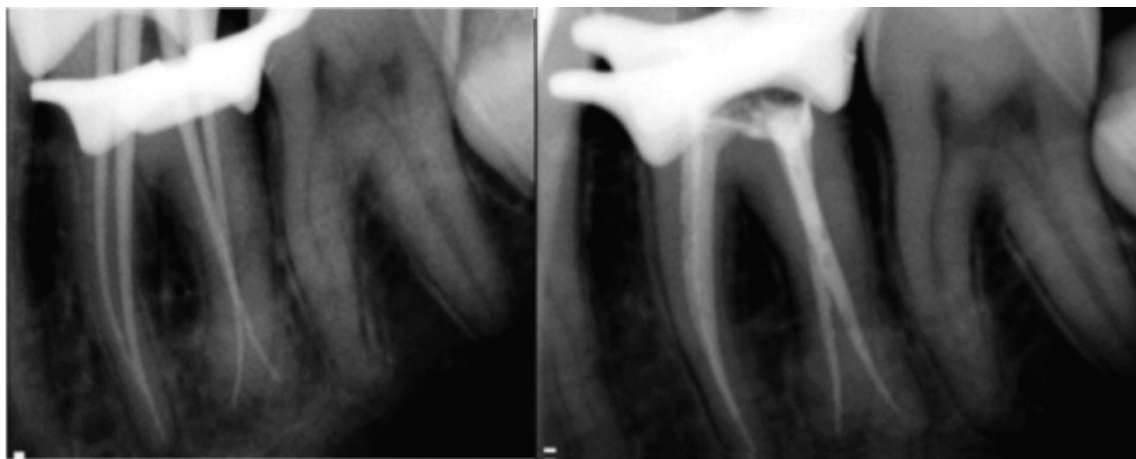
A 30-year-old female patient reported to the Department of Conservative Dentistry and

Endodontics with a chief complaint of pain in lower-right back tooth region for 2 months. The patient revealed a history of mild intermittent pain for the past 1 month, which had increased in intensity during the past 1 week. The patient reported prolonged sensitivity to hot and cold substances. The pain was spontaneous and aggravated particularly at night. Clinical examination revealed deep occlusal carious lesions on mandibular first molar. The tooth 46 was tender to vertical percussion. The preoperative radiograph revealed radiolucency of carious lesion involving the pulp with respect to 46. Based on the clinical and radiographic findings, a diagnosis of symptomatic irreversible pulpitis with symptomatic apical periodontitis with respect to 46 was made, informed consent was obtained, and endodontic treatment was initiated.



**Preoperative**

**Working Length**



**Master Cone**

**Obturation**

## CLINICAL MANAGEMENT

After a consent from the patients, local anaesthesia was administered with 1: 80,000 epinephrine and isolation was done with a rubber dam. After endodontic access cavity preparation, a clinical examination was carried out with a DG16 endodontic explorer. Upon close examination found two mesial and two distal canals. In the subsequent visits, canals were explored and negotiated using #08 and #10 size K-files. The working length of the canals was determined electronically using an apex locator and confirmed radiographically. Canals were cleaned and shaped using neo endo rotary files. Canals were irrigated using 2.5% sodium hypochlorite solution. In both the cases, the finding of a separate disto-lingual canal orifice and radiographic outline of the roots in the subsequent radiographs indicated the presence of an RE. In the next visit after a week, the canals were dried using paper points, master cone radiograph was taken, and obturation was done. The access cavity was restored with temporary restoration, postobturation radiograph was taken, and the patient was scheduled for full coverage restoration.

## DISCUSSION

Radix entomolaris, first described by Carabelli, is an anatomical variant in the first permanent mandibular molar typically characterized by an additional third root located distolingually. RE occurs in first, second and third molars with the lowest prevalence in second mandibular molars.<sup>4,5,6</sup>

**Classification:** Carlsen & Alexandersen et al (1990) classified radix entomolaris (RE) into four different types based on the location of its cervical part<sup>7</sup>:

1. Type A: the RE is located lingually to the distal root complex which has two cone-shaped macrostructures.
2. Type B: the RE is located lingually to the distal root complex which has one cone-shaped macrostructures.
3. Type C: the RE is located lingually to the mesial root complex.
4. Type AC: the RE is located lingually between the mesial and distal root complexes.

De Moor et al. (2004) classified radix entomolaris based on the curvature of the root or root canal<sup>8</sup>:

1. Type 1: a straight root or root canal.
2. Type 2: a curved coronal third which becomes straighter in the middle and apical third.
3. Type 3: an initial curve in the coronal third with a second buccally oriented curve which begins in the middle or apical third.

Song JS et al. (2010) further added two more newly defined variants of Re<sup>9</sup>:

1. Small type: length shorter than half of the length of the distobuccal root.
2. Conical type: smaller than the small type and having no root canal within it.

Endodontic treatment success in the presence of RE mainly depends on its diagnosis, treatment plan, anatomy of morphology assessment, canal configuration, and approaching the tooth clinically<sup>10</sup>.

Apart from the awareness about the possible existence of RE, factors such as an extra cusp, prominent distolingual lobe, cervical convexity, complex external contour of the furcation can indicate the presence of an RE. Radiographically, double periodontal ligament images or an unclear view or outline of the distal root contour or the root canal can give hint to the presence of an RE. However, this requires a thorough inspection of the preoperative radiograph.<sup>11</sup>

Modification of the conventional triangular access to obtain rectangular or trapezoidal outline form assists in locating the orifice of RE. Since canal entrances are equidistant from a line drawn in a mesiodistal (MD) direction through the pulp chamber floor and lie on a line perpendicular to this MD line across the centre of the floor of the pulp chamber, following the laws of symmetry helps in both detecting and locating an RE.<sup>10</sup>

A clinical approach to endodontically treat an RE should consist of adopting measures to minimize complications. An initial relocation of the orifice to the lingual without excessive removal of dentin helps to achieve straight-line access and avoid perforations. Manual preflaring is recommended to prevent instrument separation. It is said that RE exhibits

the greatest degrees of curvature among the other roots of a mandibular molar with its canal having relatively longer length and smaller radius of curvature. As the risk of instrument fracture significantly increases with the decrease in the radius of curvature, canal preflaring with manual use of stainless steel files is suggested to overcome instrument fracture. Initial root canal exploration with small files (size 10 or less), creation of a glide path along with the proper determination of the canal curvature and working length would reduce the procedural errors such as ledging and transportation. Finally, use of nickel-titanium rotary files having a taper of not more than 0.04 taper and crown down technique is said to allow a more centered, rounder and conservative canal preparation than the use of stainless steel instruments in RE.<sup>12</sup>

## CONCLUSION

Failure to identify and treat an RE can significantly affect the outcome of an endodontic treatment. Angulated radiographs can play a key role in the identification radix entomolaris and also clinician should have thorough knowledge about prevalence, diagnosis, morphology, canal configuration of an RE.

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